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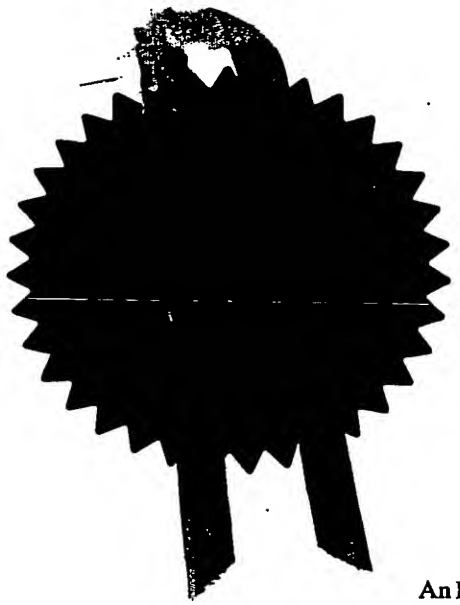

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Dated 30 December 2003

06/02/047S – ISSUE 1

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Request for grant of a patent

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1. Your reference — 06/02/047S – ISSUE 1

2. Patent application number — 0214636.3
22 JUN 2002

3. Full name, address and postcode of the applicant — AES ENGINEERING LTD
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4. Title of the invention — A LOW COST MECHANICAL SEAL

5. Name of agent — Harrison Goddard Foote

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7. Parent application (e.g. Divisional) — Earlier Application No — Date of Filing

8. Statement of Inventorship needed? **YES**

9. Number of sheets for any of the following (not counting copies of same document)

Continuation sheets of this form	
Description	**14 pages**
Claims	~~26~~ **(4 pages)**
Abstract	
Drawings	**12 (12 pages of drawings)**

only 8

10. Number of other documents attached

Priority documents	
Translations of priority documents	
P7/77	
P9/77	
P10/77	
Other documents	Abstract on last page of claims

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 22nd June 2002

12. Name and daytime telephone number of person to contact in the United Kingdom.

Alan Roddis
01709 369966

A low cost mechanical seal

This invention relates to mechanical seals which are fitted to rotating equipment in virtually all types of industries.

A Mechanical seal comprises a "floating" component which is mounted axially movably around the rotary shaft of, for example, a pump and a "static" component which is axially fixed, typically being secured to a housing. The floating component has a flat annular end face, i.e. its seal face, directed towards a complementary seal face of the static component. The floating component is urged towards the static component to close the seal faces together to form a sliding face seal, usually by means of one or more spring members. In use, one of the floating and static components rotates; this component is therefore referred to as the rotary component. The other of the floating and static components does not rotate and is referred to as the stationary component.

Those seals whose floating component is rotary are described as rotary seals. If the floating component is stationary, the seal is referred to as a stationary seal.

If the sliding seal between the Rotary and Stationary components are assembled and pre-set prior to despatch from the Mechanical seal manufacturing premises, the industry terminology for this is "cartridge seal". If the Rotary and Stationary components are despatched individually (unassembled) from the Mechanical seal manufacturing premises, the industry terminology for this is "component seal".

Mechanical seals are used in all types of industries to seal a variety of different process media and operating conditions. The general industry term which defines the area adjacent to the process media is "inboard". The industry term which defines the area adjacent to the

atmospheric side is "outboard".

Like most industries, the mechanical seal industry is highly competitive.

As a result, mechanical seal manufacturers constantly seek methods of improving competitive advantage.

With the exception of the mechanical seal faces, the most costly item of a cartridge mechanical seal is the gland plate.

The raw material for a Gland plate is typically either cast metal or produced from solid metal bar. Alternate material types such as plastic are also occasionally used. Subsequent machining operations on the gland plate raw material are required in order to accuracy fit the mating components.

For most types of mechanical seals, typically, one seal gland is employed for each size of seal in both single and double seal formats. With over 30 standard seal sizes, in any given product range and at least two gland formats, the companies gland plate inventory costs can be considerable.

Furthermore gland production costs are high due to the number of manufacturing operations required to process a given gland. Some companies move their gland plate manufacturing centres to countries, which are deemed to be low cost environments in order to reduce manufacturing costs.

However, they fail to considerably reduce manufacturing costs since a conventional gland plate design has both material cost and machining cost.

A design, which offers a seal gland, which is designed and manufactured in an economical manner irrespective of manufacturing location, is deemed to be particularly advantageous. This is due to the fact that the inventory costs of the gland plate(s) will be low and / or the unit cost of the mechanical seal will be kept to a minimum. This has obvious advantages for maintaining a low customer selling price.

It is deemed to be further advantageous to minimise the absolute number of manufacturing operations required to process said gland. A design where the raw material creation process thereafter has no subsequent machining operations such as turning, milling or drilling is of further advantage.

Furthermore, it is advantageous if the seal assembly incorporates a minimum number of components, and / or the components are of simple construction, thereby helping further to reduce the cost of the assembly.

Figure 1, shows a cross sectional view of a conventional prior art single cartridge mechanical seal.

Figure 2, shows a cross sectional view of a single cartridge mechanical seal of the invention. Figure 2b shows an alternate setting clip arrangement.

Figure 3, corresponds to Figure 2 and shows a cross sectional view of the gland plate assembly of the invention.

Figure 4, corresponds to Figure 2 and 3 and shows an isometric of the two pressed components which, when assembled, make the gland plate assembly of the invention.

Figure 5, corresponds to Figure 4 and shows an exploded isometric view of the two pressed components which, when assembled, make the gland plate assembly of the invention.

Figure 6 shows an alternate single cartridge seal of the invention, showing by way of example only, a different gland plate assembly.

Figure 7 corresponds to Figure 6, and/or Figure 4 and shows quarter isometric cutaway of the gland plate assembly of the invention.

Figure 8 illustrates an alternate design of the invention, showing an alternate shaft-sealing device.

Figure 9 illustrates an alternate design of the invention, showing a single component seal arrangement.

Figure 10 illustrates an alternate design of the invention, showing a double cartridge seal arrangement.

Figure 11 illustrates an alternate design of the invention, showing a double component seal arrangement.

Figure 12 illustrates an alternate design of the invention, showing a gland plate assembly and packing arrangement.

An experienced person in the art of engineering production would recognise that the prior-art gland plate (1) design, shown in *Figures 1* requires a considerable number of machining operations and machine set-ups to allow mating components to be assembled.

The total cost price of the gland plate (1) is a sum of said machining costs and the cost of the raw material. The raw material in Figure 1 is shown as a casting. If the gland is manufactured from a solid

material, the raw material cost could be lower; however, the machining costs are typically considerably more.

Figure 2 therefore shows a single cartridge mechanical seal (4) of the invention.

From *Figure-2*, of the invention, the rotary and axially floating seal face (11) is spring biased towards a static stationary seal face (12). The rotary seal face (11) is allowed to slide on the static seal face (12). The interface between the rotary seal face (11) and stationary seal face (12) forms sealing area (13). This sealing area (13) is the primary seal that prevents the process media (14) from escaping from the process chamber (15).

In addition to the sliding seal face (13), the process media (14) is sealed by a sleeve elastomer (16) in contact with the shaft (17) and sleeve (18). This has been termed the first secondary sealing area.

The second secondary sealing area is formed between stationary seal face (12) and stationary gland plate assembly (21) using elastomeric member (22).

The third secondary sealing area is formed between the rotary seal face (11) and the sleeve (18) using elastomeric member (24).

The fourth secondary sealing area is formed between the gland plate assembly (21) and the process chamber (15) using gasket (26).

The four secondary sealing devices and the primary sliding sealing interface prevent the process media (14) from escaping from the process chamber (15).

The static seal face (12) is prevented from rotating by radial squeeze between the elastomeric member (22) and the gland plate assembly (21). It is deemed obvious that an alternate anti-rotation device could be incorporated into the design if so desired.

The sleeve (18) is axially terminated adjacent to the clamp ring (23) which contains at least one screw (28) for securing the seal assembly (25) to the shaft (17). Said screw (28) provides rotational drive from shaft (17) to the rotary components in the seal assembly (26). Rotary seal face holder assembly (26) consists of at least one holder (27). Said holder, preferably metallic in construction, transmits the axial spring (28) force to the seal face (11).

Preferably, although not essential, at least one setting clip (29) is used to position the axial and/or radial distance between the rotating clamp ring (23) and gland plate assembly (21).

The setting clip could be either removable using clip screw (5) or, as shown in Figure 2b, setting clip (6) could be a sacrificial wearing member of seal assembly (25).

It is deemed obvious that sacrificial clip (6) may be of continuous circular construction and not split into segments. It is further deemed obvious that since sacrificial clip (6) is a potentially wearing component, it should be made from a suitable material such as plastic or brass.

Furthermore, if clip (6) has a continuous circular section, it should be sufficiently flexible to allow engagement into the gland clip recess (7).

Figure 3, corresponds to Figure 2 and shows a partial cross section through the gland plate assembly (21).

The gland plate assembly (21) is typically constructed from more than one part. The front plate (30) aligns on at least one feature with the rear plate (31). Preferable alignment is made on either the outer radial portion (32) of the front plate (30) or the inner radial portion (33) of the front plate (30). As shown in Figure 3 it is preferable if said location features are both the inner (33) and outer (32) radial portions of the front gland plate (30) since this provides strength to the gland plate assembly (21). This also provides a surface where an adhesive could be applied.

It is deemed obvious that said location features on the front gland plate (30) could be of any shape or size, and/or positioned in the rear gland plate (31), or positioned on any combination of both front (30) and rear (31) gland plates.

Since both front (30) and rear (31) gland plates are manufactured from pressed material steel, preferably a non-corrosive steel material such as stainless steel, the gland plate assembly (21) manufacturing costs are extremely low.

The experienced reader will note that pressed sheet steel, of say 1.0mm (0.040") to 1.5mm (0.060") thickness, can be extremely strong when in designed in a manner where the physical shape of the cross section, including the bends in the material, create a rigid structure.

From Figure 3, the gland plate assembly (21) has preferably at least one bolt slot (34) which allows the gland plate assembly (21) to be fixed to the process chamber (35) mounting face, using an appropriate screw (36).

Figure 4 corresponds to Figure 3, and shows an isometric view of the gland plate assembly (21).

From Figure 4, it will be noted that the gland plate assembly (21) has preferably four-bolt slots (34) equal spaced which allows it to be fixed to the process chamber. It will be further noted that preferably the gland plate assembly (21) is held together both axially and rotationally by at least one crimp indentation (37) in the outer radial surface of the gland plate assembly (21).

Again, it is preferable if said gland plate assembly (21) is further held together by either a suitable adhesive, chemical bond and/or permanent physical operation such as welding.

From figure 3, should the design of the invention be constructed from more than one piece of sheet metal, particularly around the bolt slot area (34), the slots (38 and 39) in both front (30) and back (31) plates should align with each other.

Figure 5 illustrates an isometric view of the front (30) and back (31) plates, which make up the respective gland plate assembly (21) shown in Figure 4.

During the gland plate (30) and (31) manufacturing process, the bolt slots (39) and (38), of the invention are typically formed in the sheet material by a pressing or punching operation. During said operation, the sheet material is displaced (40). The displaced material (40) surrounding the circumference of the slot (38) and (39) is advantageous as this provides strength to this area of the gland plates (30) and (31). This is important since at least one screw and the resulting clamping force from the screw is transmitted into this area of the gland plate (30) and (31).

It is deemed to be of further benefit, when at least two gland plates, front (30) and back (31) are utilised in the gland plate assembly (21) as the combined strength is a multiple of the two components.

From Figure 3, it is deemed advantages, although not essential, to allow the axial end (41) of the displaced slots (38) and (39) in the both front (30) and back (31) plates to butt against each other.

If both axial ends (41) of the displaced slots butt against each other, the resulting compressive force from screw (36) has to buckle the displaced material surrounding either slot (38) and (39), particularly if the gland back face is flush against the process chamber face (35). This butted displaced slot design therefore very strong and able to withstand compressive loads from screws or bolts acting through the slots (38) and (39).

From Figure 3, it is of further advantage if the front gland plate (130) axially locates against the back gland plate (31) at its outwardly radial and axial position (41) and/or its inwardly radial and axial position (42). Therefore as compressive force is applied from the screw (36), the outer and inner most radial portions of the front gland plate (30) gain axial support from the back gland plate (31).

Figure 6 shows another single cartridge seal design of the invention. The gland plate assembly (50) is extended axially away from the gasket (51) bolting face thereby allowing the stationary seal face (52) and corresponding rotary seal face (53) to be positioned further outboard to that of Figure 2.

This offers certain advantages, for example, if a rotary seal face head (53) is radially too large for the rotating equipment seal chamber bore (54), the design shown in Figure 6 allows the rotating seal face head (53) to be positioned in the gland plate assembly (50). This prevents rotating equipment modifications.

Alternatively, if there is insufficient axial room due to an obstruction (56) inside the rotating equipment, the rotating seal face (53) and

sleeve (55) can be positioned axially away from the obstruction (56). This design shown in Figure 6 is therefore of considerable benefit.

Figure 7 corresponds to Figure 6 and/or 4 and illustrates a quarter cutaway of the gland plate assembly (50). It will be noted that portions of the gland plate assembly are hollow (57).

Said hollow portions (57) correspond to areas where the strength of the gland plate assembly (50) is deemed not to be critical. Should any region of the gland plate assembly (50), other than the bolt slot area (58) require strength or rigidity, then it is deemed obvious to the experienced reader that one or more protrusions, indentations, or portions of displaced material could be incorporated adjacent to said region.

Referring back to Figure 2. From Figure 2, the sleeve (18) of the invention, is ideally designed a component which may be pressed from sheet steel. While the invention is by no means limited to this, this is a preferable production process in order to maintain a low assembled seal cost price.

By way of example only, Figure 8 of the invention, illustrates an alternate sleeve (60) and sleeve elastomeric member (61).

Figure 9 illustrates a single component seal of the invention.

The gland plate assembly (70) is of similar shape to the aforementioned figures, however the seal design is a component design not a cartridge design which incorporates a sleeve member.

It will be obvious that the design in Figure 9 has fewer components than that of the cartridge seal variant and therefore will be a produced at a lower cost price.

By way of example only, Figure 9 shows a pump setting component (71) which axially positions the rotary seal face assembly (72) in terms of the correct spring (73) working length.

Figure-10 shows the double seal (100) version of the invention. Once again the rotary and axially floating seal face (101) is spring biased towards a static stationary seal face (102). The rotary seal face (101) is allowed to slide on the static seal face (102). The interface between the rotary seal face (101) and stationary seal face (102) forms sealing area (103). This sealing area (103) is the primary seal that prevents the process media (104) from escaping from the process chamber (105). The other secondary inboard sealing points remain identical in concept to *Figure-2*.

Towards the outboard side of the seal, the outboard rotary and axially floating seal face (118) is spring biased towards a static stationary seal face (119). The rotary seal face (118) is allowed to slide on the static seal face (119). The interface between the rotary seal face (118) and stationary seal face (119) forms sealing area (120). This outboard sealing area (120) is the primary seal that prevents the barrier media (121) from escaping from the barrier chamber (114). The barrier media (121) is also sealed at the inboard side of the assembly, by sealing area (103).

At the outboard side, the secondary sealing areas include elastomeric member (117) and elastomers (137) and (138).

Once again the static outboard seal face (119) is prevented from rotating by the frictional drive of elastomeric member (117) against gland (122). It is deemed obvious that the gland could easily incorporate an alternate anti-rotation drive mechanism such as a pressed lug, or a pin and slot arrangement.

An intermediate component (123) is positioned between the two stationary seal faces (102) and (119). Said intermediate component (123) is preferably manufactured from a press steel plate of thin thickness, however, an experienced reader will understand that this intermediate component (123) could equally be a machined item.

Figure 10, shows by way of example only, that the gland plate assembly (124) is manufactured from three, pressed, preferably sheet steel, components. It may be seen from figure 10 that the invention is not limited to a particular number of pressed sheet steel components which make up the gland plate assembly. Sufficiently to state that such pressed steel components are positioned in such a way to provide the gland plate assembly (124) with strength at a low manufactured cost. Therefore, the gland plate assembly (124) of the invention contains at least one pressed steel component.

The rest of the parts in the assembly are common to most mechanical seals and will not be further discussed.

Once again, from Figure 10, an experienced reader will note that the gland plate assembly (124) is designed in such a way as to eliminated or limit subsequent conventional machining operations.

From Figure 10, barrier media (121) enters insertion hole (125). Preferably a corresponding insertion hole is punched through the sheet metal gland plate assembly (124) and sealed via an appropriate rubber washer (127) and (128), if necessary, at either side of the insertion hole (126).

Barrier media (121) enters the barrier chamber (114) preferably via a plastic tube (129) inserted through a rubber washer (127 and 128) and fitting (130) arrangement. This provides a pressure, leak tight joint. Said barrier fluid (121) lubricates and cools seal faces (120) and

(103) and is evacuated via a similar hole and tube arrangement positioned at another place in the gland plate assembly (124).

From Figure 10 it can be seen that a pipe (129) and fitting assembly (130) has been incorporated into the hollow cavity (131) of the gland plate assembly (124).

Said fittings (130) are preferably of "panel" type construction. Experienced readers will understand that said panel type fittings (130) are ideal for creating a pressure tight, leak free seal in a thin sheet metal construction such as the gland plate assembly (124).

Said panel fittings (130) and (132) are fitted to the punched holes (126) and (133). A pipe (129) connects said fittings, (130) and (132) providing a pressure tight joint. Said pipe is preferably a plastic tube. Said fittings (130) and (132) preferably accommodate said plastic pipe (129) with a "push-fit", leak tight seal. Clearly the invention is not limited to this pipe (129) and fitting (130) and (132) construction, however said construction is a particular low cost option.

Said fitting and pipe assembly (134) would be typically be installed prior to assembling the rear gland plate flange (135) to the front gland plate flange (136). It is deemed obvious that the front gland plate (136) will have an opening, which corresponds, to the fitting position in the rear gland plate (135), thereby allowing the joining of both flanges, which create the gland plate assembly (124).

Figure 12 illustrates a double component seal of the invention.
The gland plate assembly (140) is of similar shape to the aforementioned figures, however the seal design is a component design not cartridge design which incorporates a sleeve member.

It is considered self evident to the experienced reader that the invention may be employed for both Rotary seals and Stationary seals, single, double or triple mechanical seals, whether designed in a cartridge or component seal format.

Furthermore, the design could be used for both pressurised and non-pressurised barrier fluid systems.

It is also considered self evident that the invention may be used with metallic components as well as non-metallic components such as plastic. Some types of equipment rotate the housing and have a stationary shaft. It is considered that the invention can be similarly applied to such designs.

From Figure 12, the gland plate assembly (150) of the invention is by no means limited for the use of a mechanical seal. Rotating equipment is often sealed by other means such as packing (151).

Packing is a traditional manner of sealing rotating equipment at a low cost. The gland plate assembly (150) of the invention is therefore particulary suited for this type of sealing since this too is a low cost option.

From Figure 12, the gland plate assembly (150) can be adopted to transmit the compressive forces from at least one screw (152) to the packing (151). This thereby creates a seal between the stationary process chamber (153) and rotating shaft (154).

It is clear that the invention has many advantages in an increasingly more competitive industrial environment, where value for money / low cost and high technical performance solutions are required.

Claims :

1 A gland plate assembly, which comprises of one or more components manufactured from a relatively thin material, said material is formed into rigid shape.

2 A gland plate assembly which comprises of one or more components manufactured from a relatively thin material, said material is formed into a shape which is sufficiently rigid to hold a stationary member which may subsequently slide relative to a corresponding rotary member.

3 A gland plate assembly which comprises of one or more components manufactured from a relatively thin material, said material is formed into a shape which is sufficiently rigid to hold a packing member, said packing member thereby creates a seal between a stationary member and a rotating member.

4 A gland plate assembly according to any previous claims, which contains one or more through slotted regions.

5 A gland plate assembly according to any previous claims which contains one or more through holes.

6 A gland plate assembly according to any previous claims where no subsequent machining operations are required after the gland plate forming operation.

7 A sealing arrangement comprising of a rotating member and a stationary member, said members slide relative to one another to form a seal, said stationary member is held in place by a gland plate assembly which comprises of one or more components manufactured from a relatively thin material, said material is formed

into a shape which is sufficiently rigid to hold in place former stationary member which slides on former rotary member.

8 A sealing arrangement comprising of a rotating member and a stationary member, said members slide relative to one another to form a seal, said stationary member is held in place by a gland plate assembly which comprises of one or more components, said gland plate assembly is manufactured from a relatively thin material using a pressing or punching operation, said material is formed into a shape which is sufficiently rigid to hold in place former stationary member which slides on former rotary member.

9 A gland plate assembly according to any previous claims which is of modular construction thereby permitting its use in more than one sealing arrangement.

10 A gland plate assembly according to any previous claims which contains at one or more through areas, adjacent to said through area is material which surrounds said through area thereby providing strength to said through area.

11 A sealing arrangement comprising of a rotating member and a stationary member, said members slide relative to one another to form a seal, said stationary member is held in place by a gland plate assembly which comprises of at least two components, said components are manufactured from a relatively thin material, said material is formed into a shape which is sufficiently rigid to hold in place former stationary member which slides on former rotary member.

12 A gland plate assembly according to any previous claims where said components comprising the gland plate assembly are mechanically, and/or chemically, and/or thermally connected together in a non-detachable method.

13 A gland plate assembly according to any previous claims where said components comprising the gland plate assembly are located relative to one another by at least one location member, said location member is an integral part of at least one of the former components.

14 A gland plate assembly according to any previous claims where said components comprising the gland plate assembly are located relative to one another by at least one location member, said location member is a separate part to any of the former components.

15 A gland plate assembly according to any previous claims where said components comprising the gland plate assembly are formed into shape by a mechanical pressing or punching operation.

16 A cartridge mechanical sealing arrangement comprising of at least one rotating member and at least one stationary member, said members slide relative to one another to form a seal, said stationary member is held in place by a gland plate assembly which comprises of one or more components, said gland plate assembly is manufactured from a relatively thin material using a pressing or punching operation, said material is formed into a shape which is sufficiently rigid to hold in place former stationary member which slides on former rotary member, said rotary member is held in respective position to said stationary member by a sleeve which terminates adjacent to a clamp ring used to secure the rotating members of the cartridge mechanical seal to the rotating

members of the item of rotating equipment.

17 A gland plate assembly according to any previous claims which contains at least one fitting, said fitting connects two regions of the mechanical seal, allowing a fluid to be passed between the two regions.

18 A gland plate assembly according to any previous claims which contains at least one fitting and at least one connecting pipe, said fitting and pipe connects two regions of the mechanical seal, allowing a fluid to be communicated between the two regions, said fitting and pipe are positioned in the hollow cavity created by at least two components which comprise the gland plate assembly.

19 A mechanical seal according to any of the preceding claims substantially as described here with reference to *Figures 2* to *12* of the accompanying drawings.

20 A gland plate assembly according to claim 1 and claim 2 and substantially as herein described.

Abstract

A low cost mechanical seal.

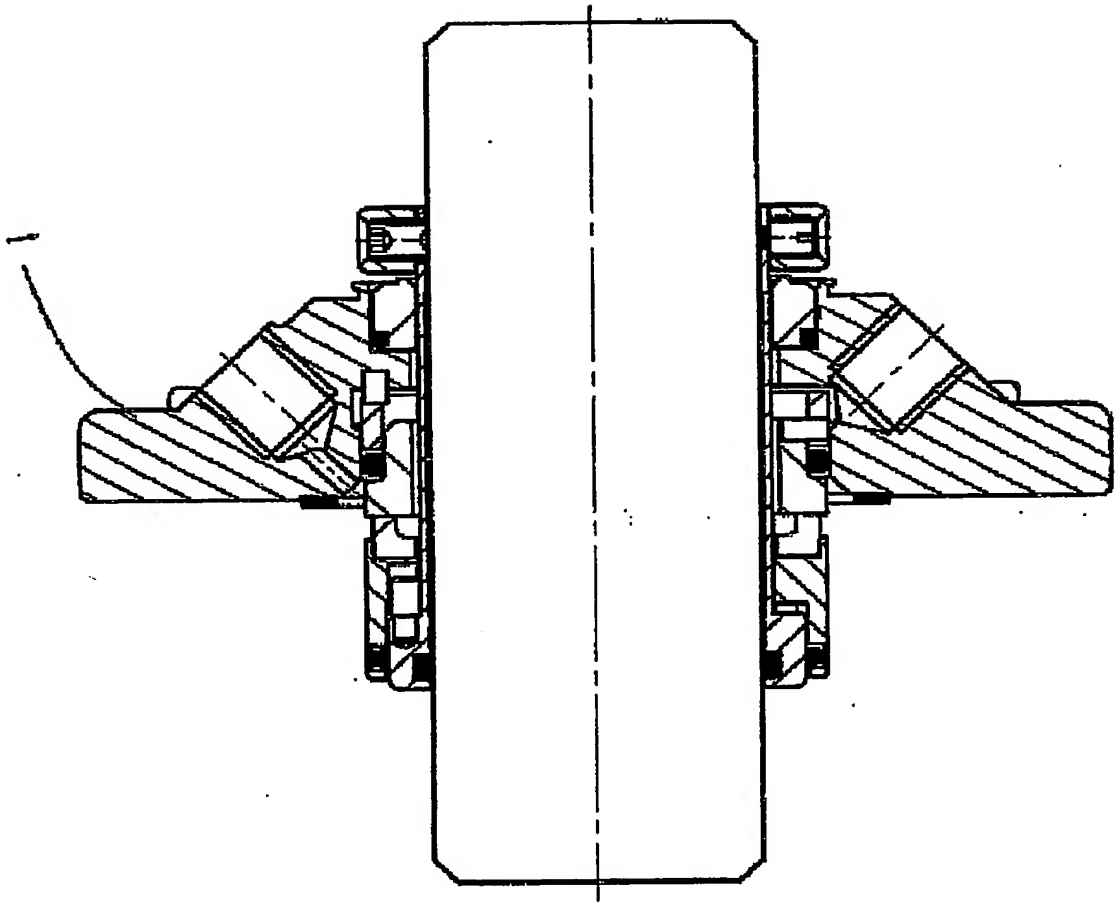

Fig. 1

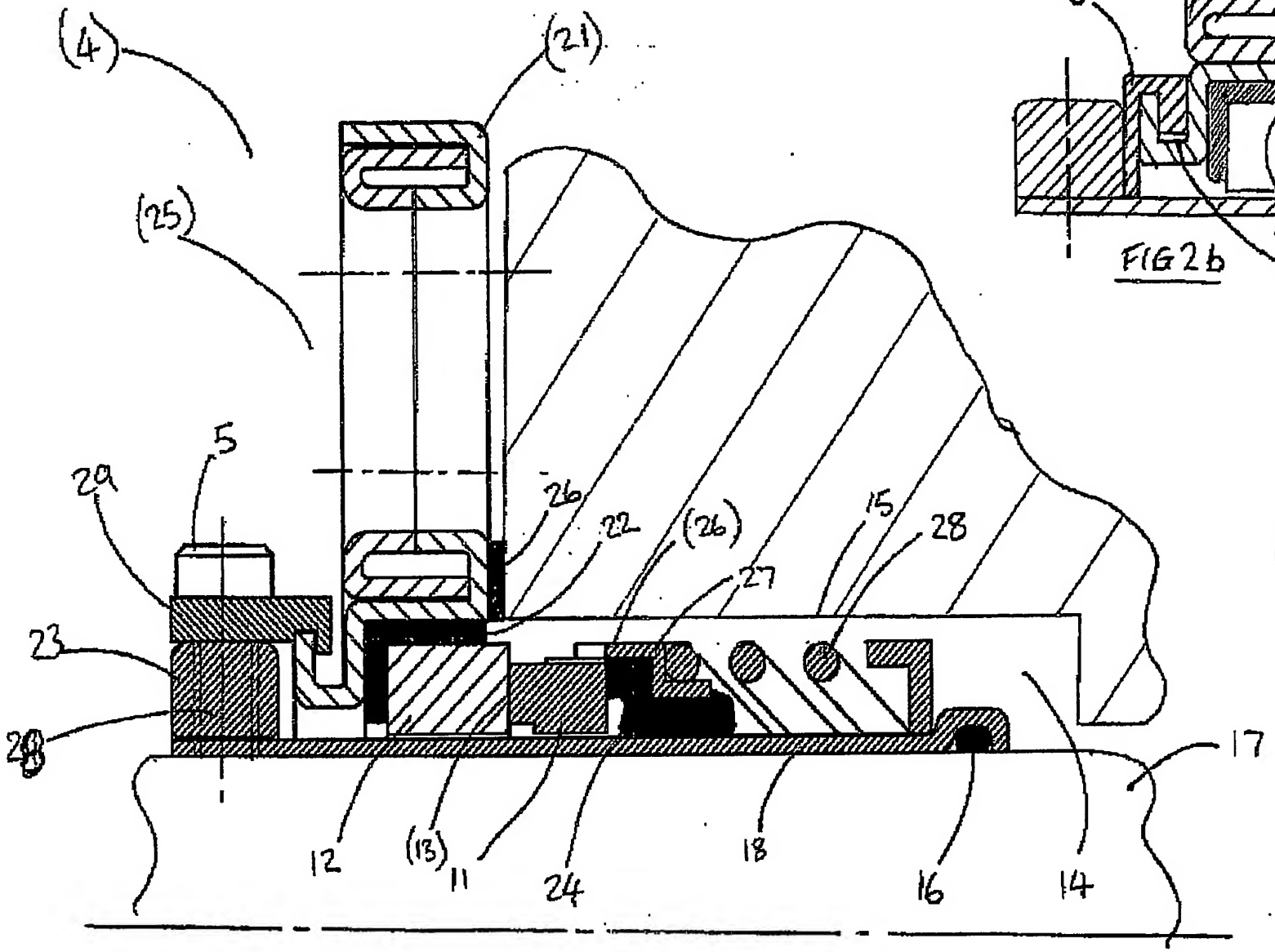

Fig. 2

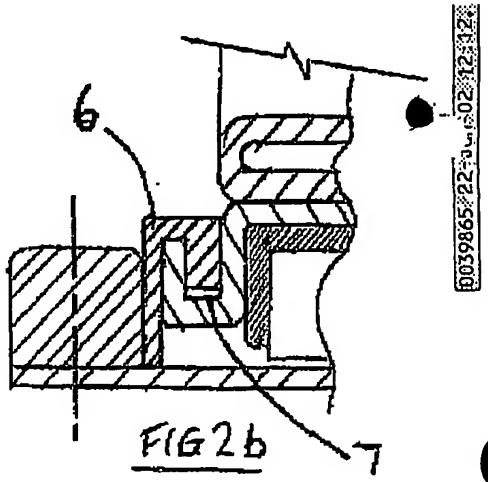

FIG 2b

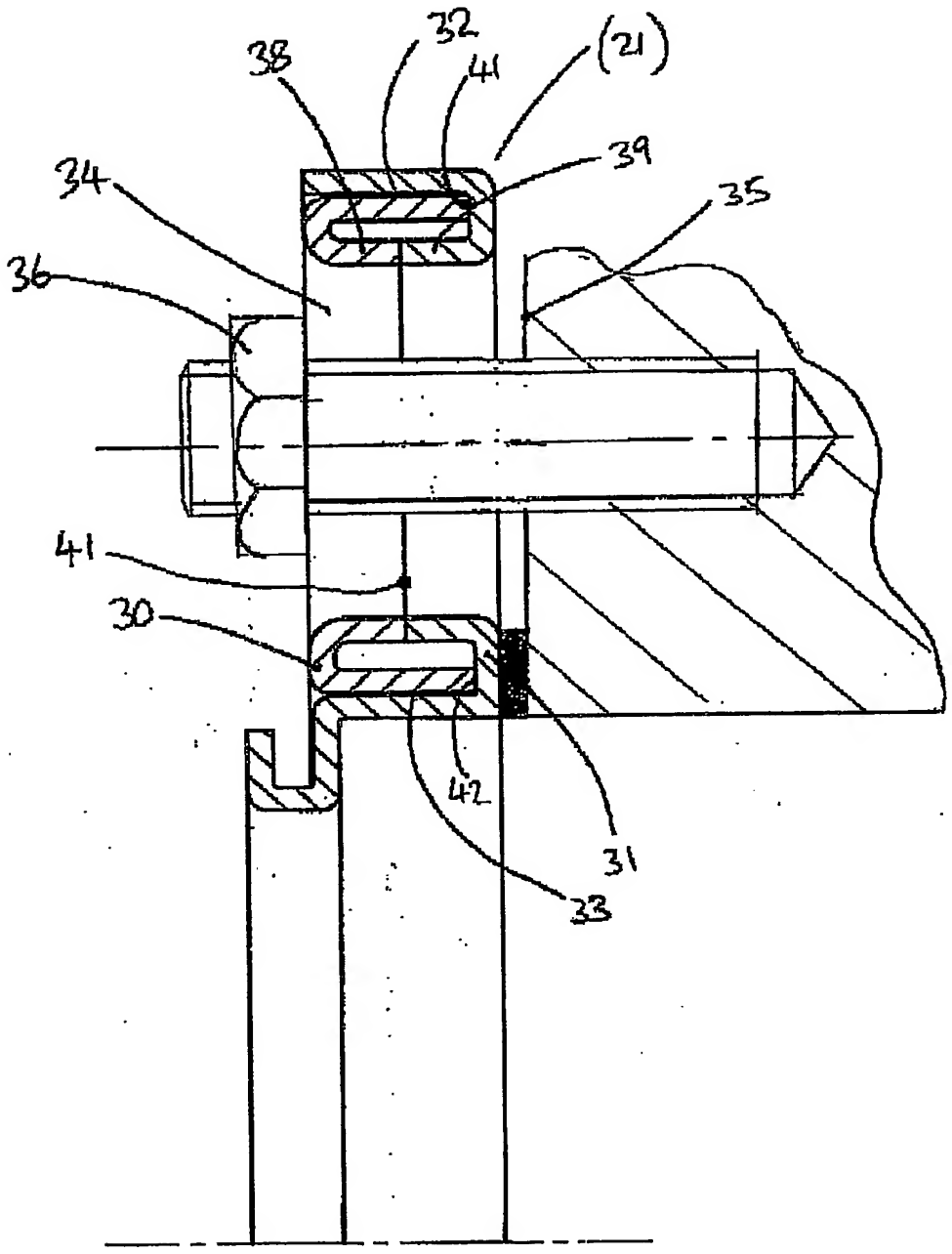

Fig. 3

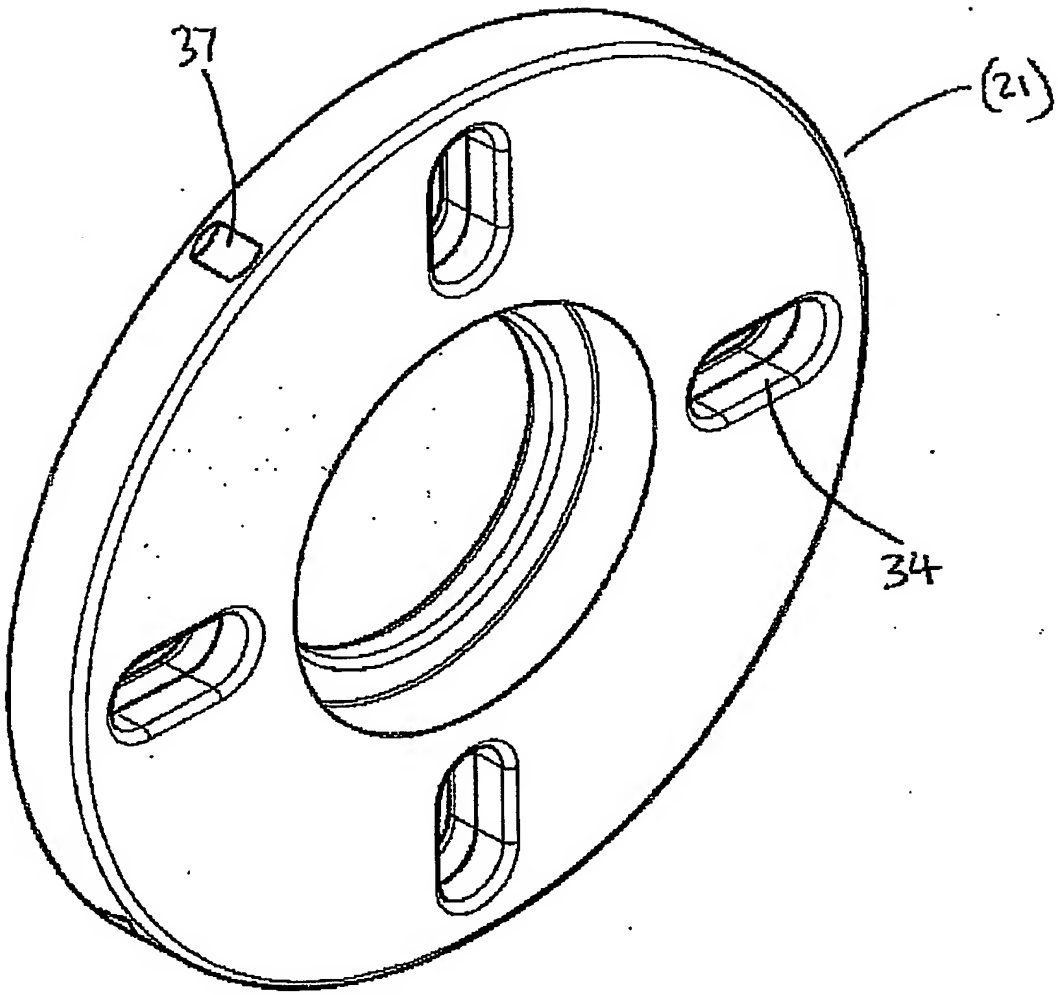

Fig. 4

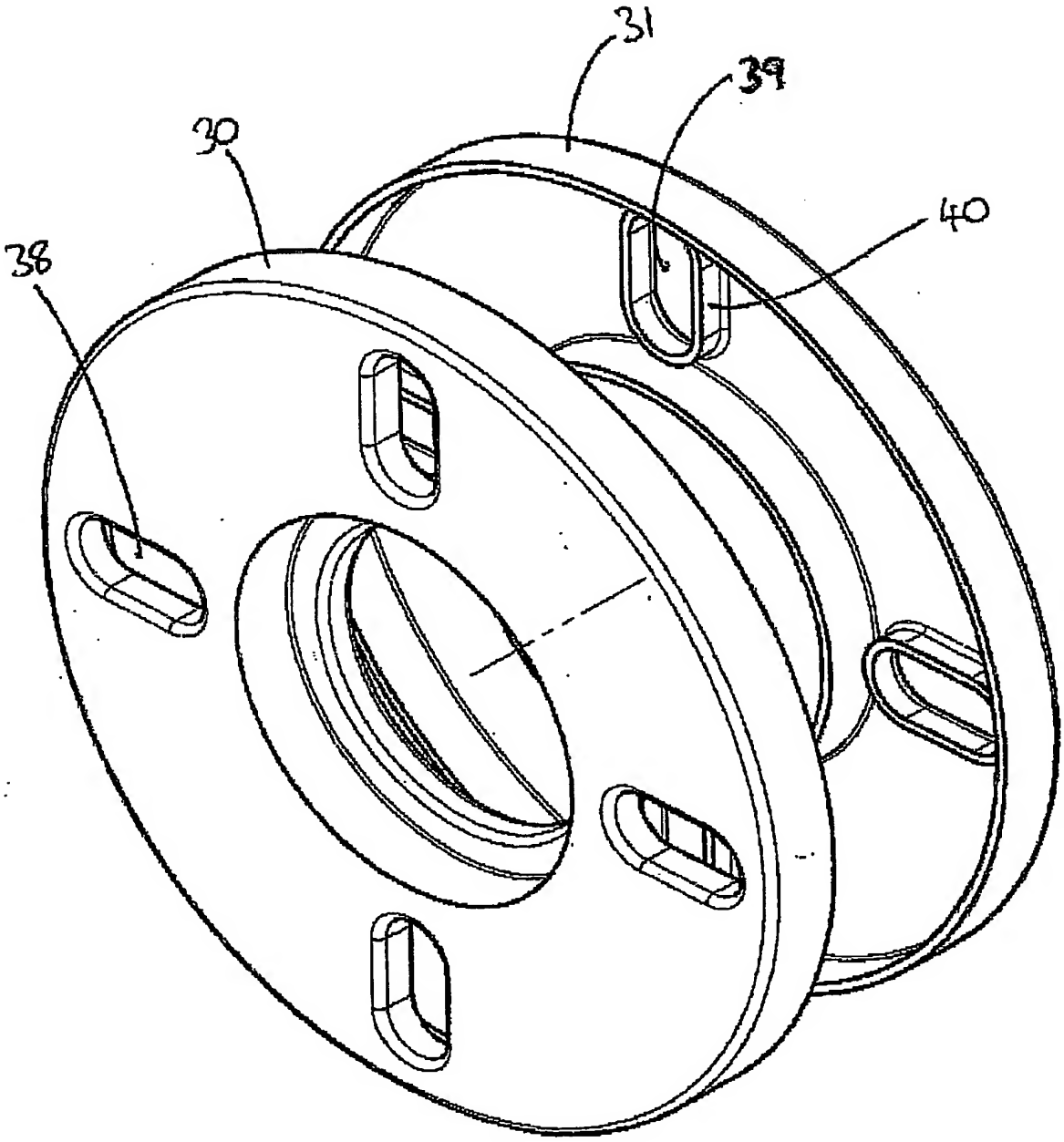

Fig. 5

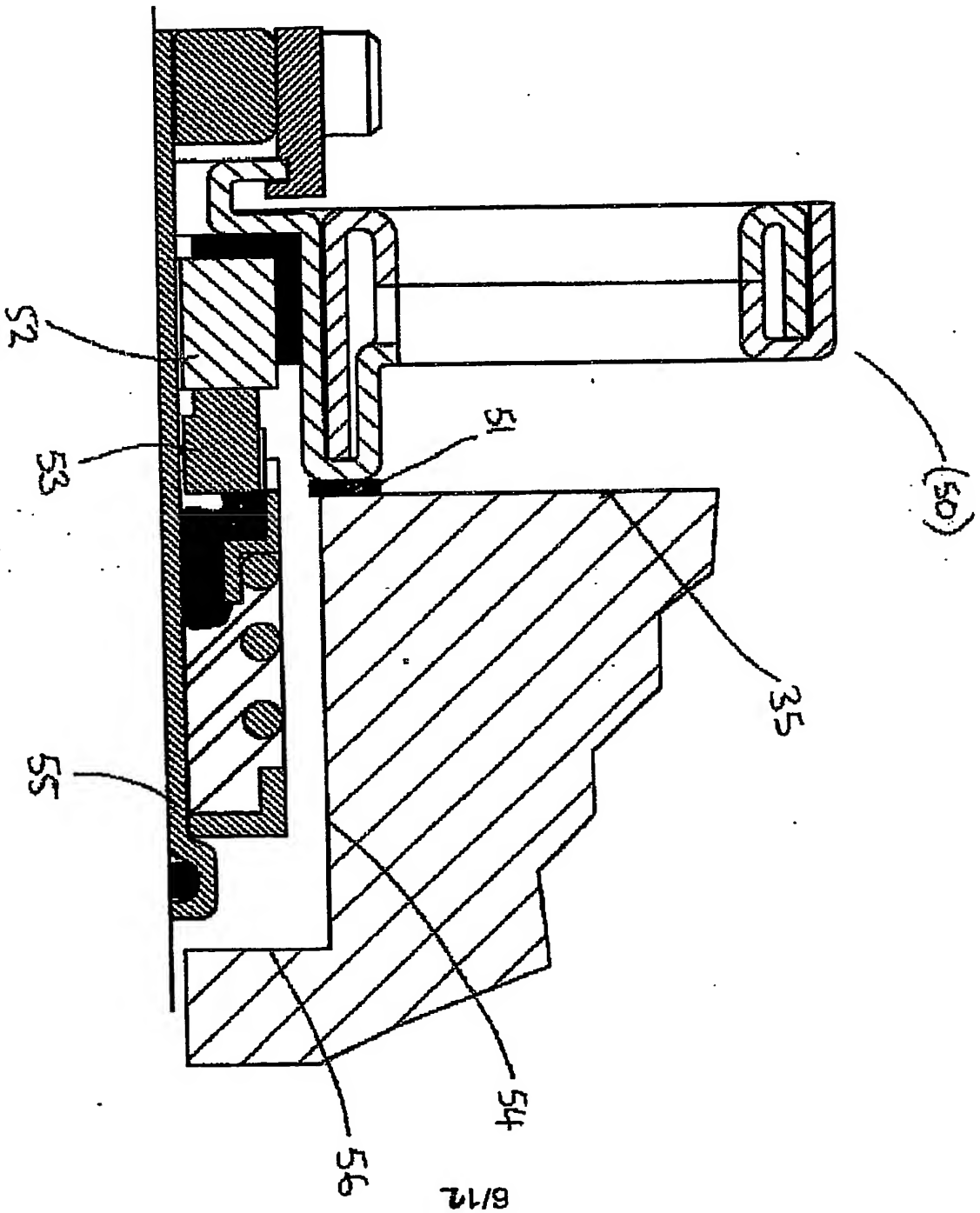

Fig. 6

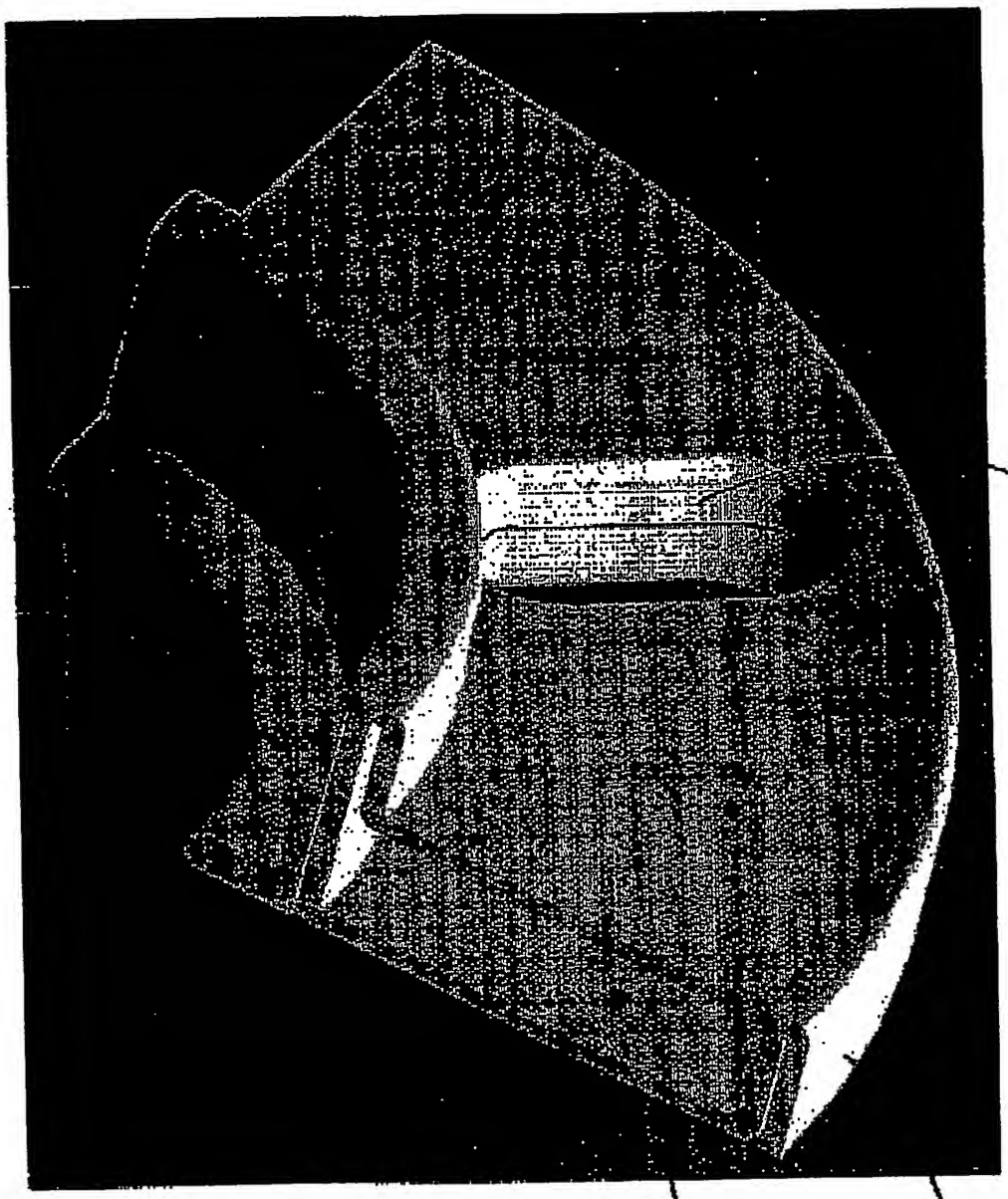

Fig.7

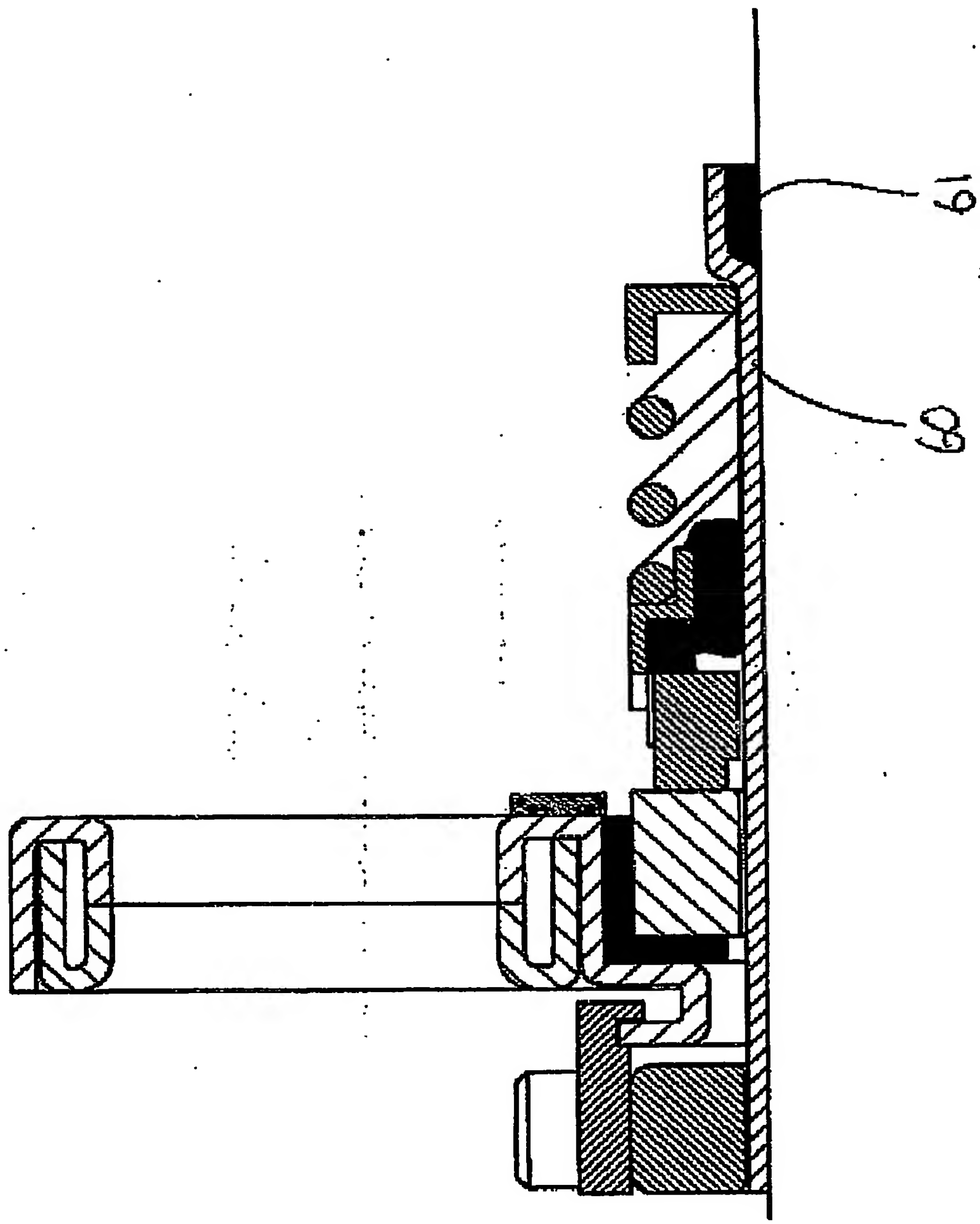

Fig. 8

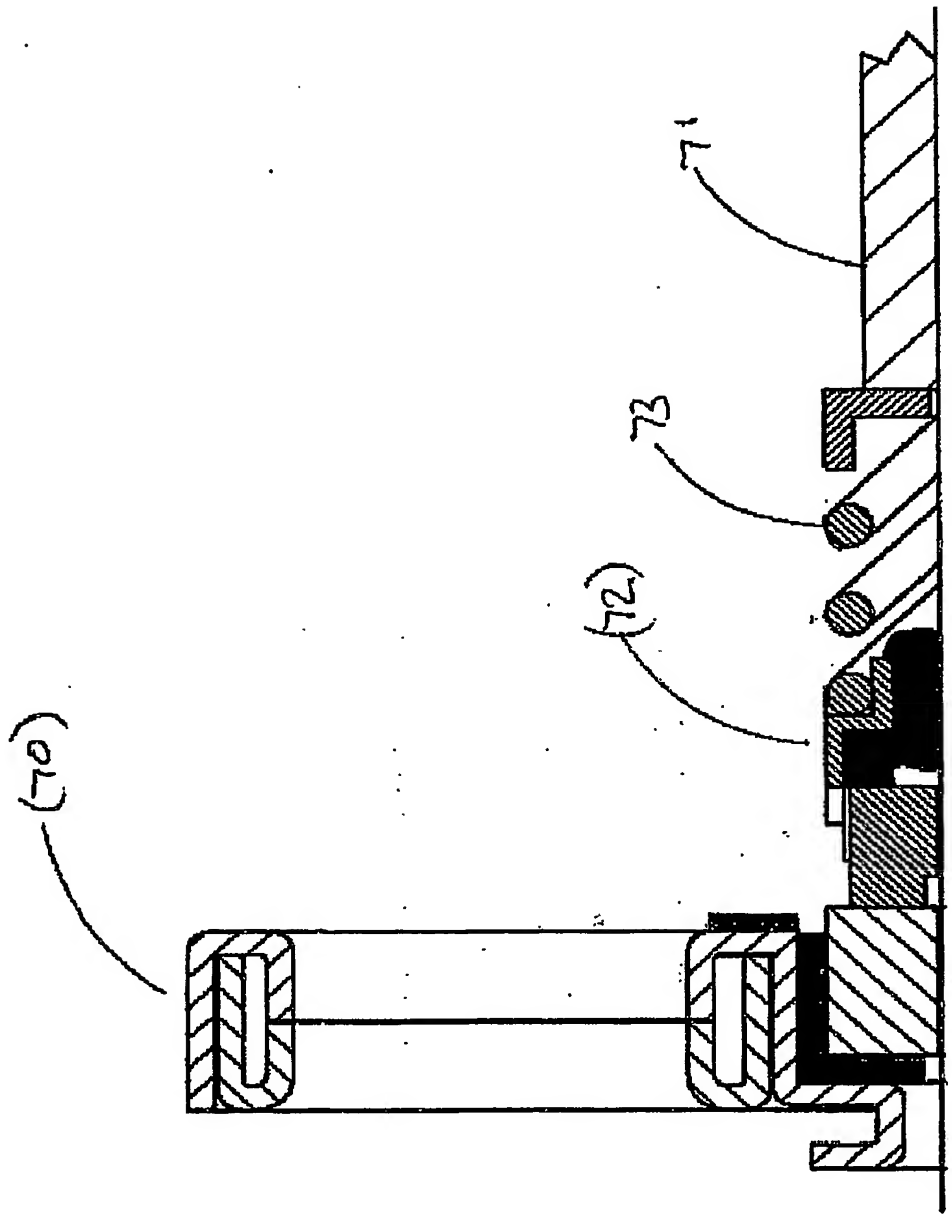

Fig. 9

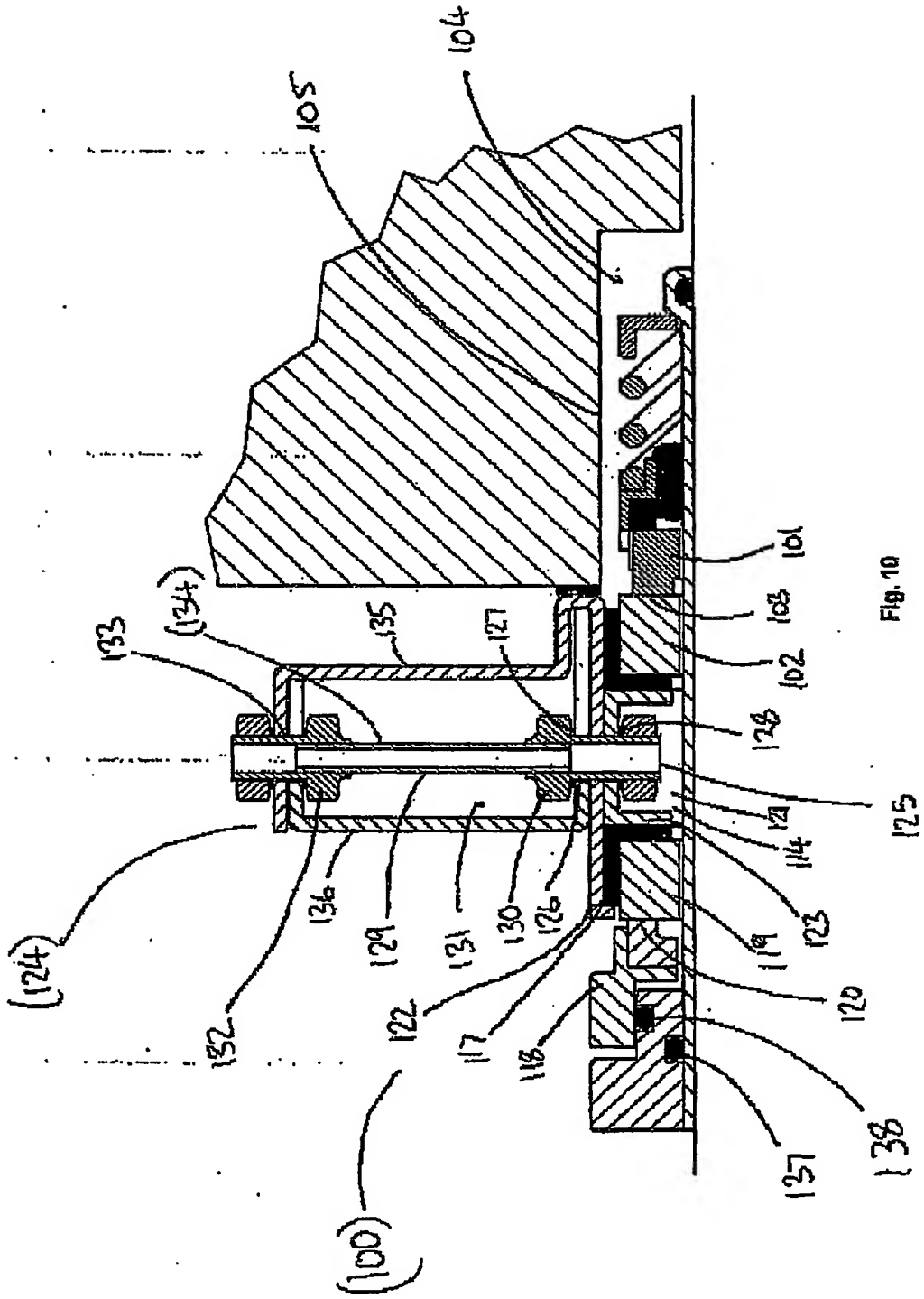

Fig. 10

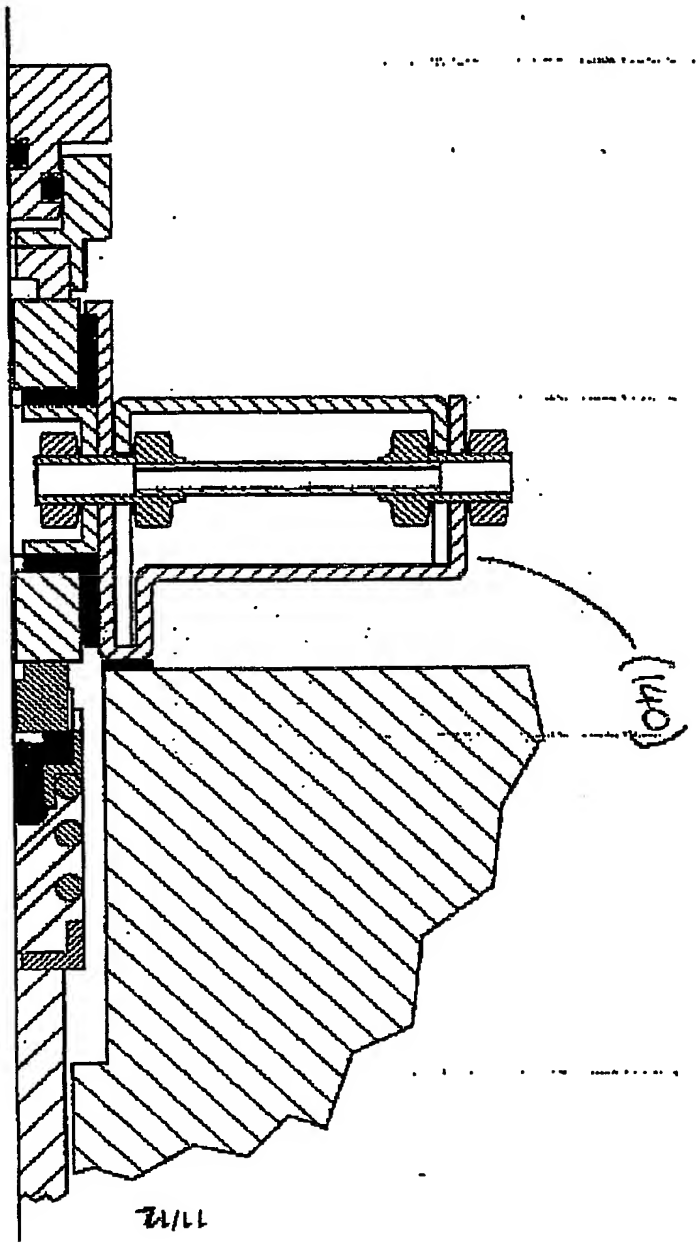

Fig. 11

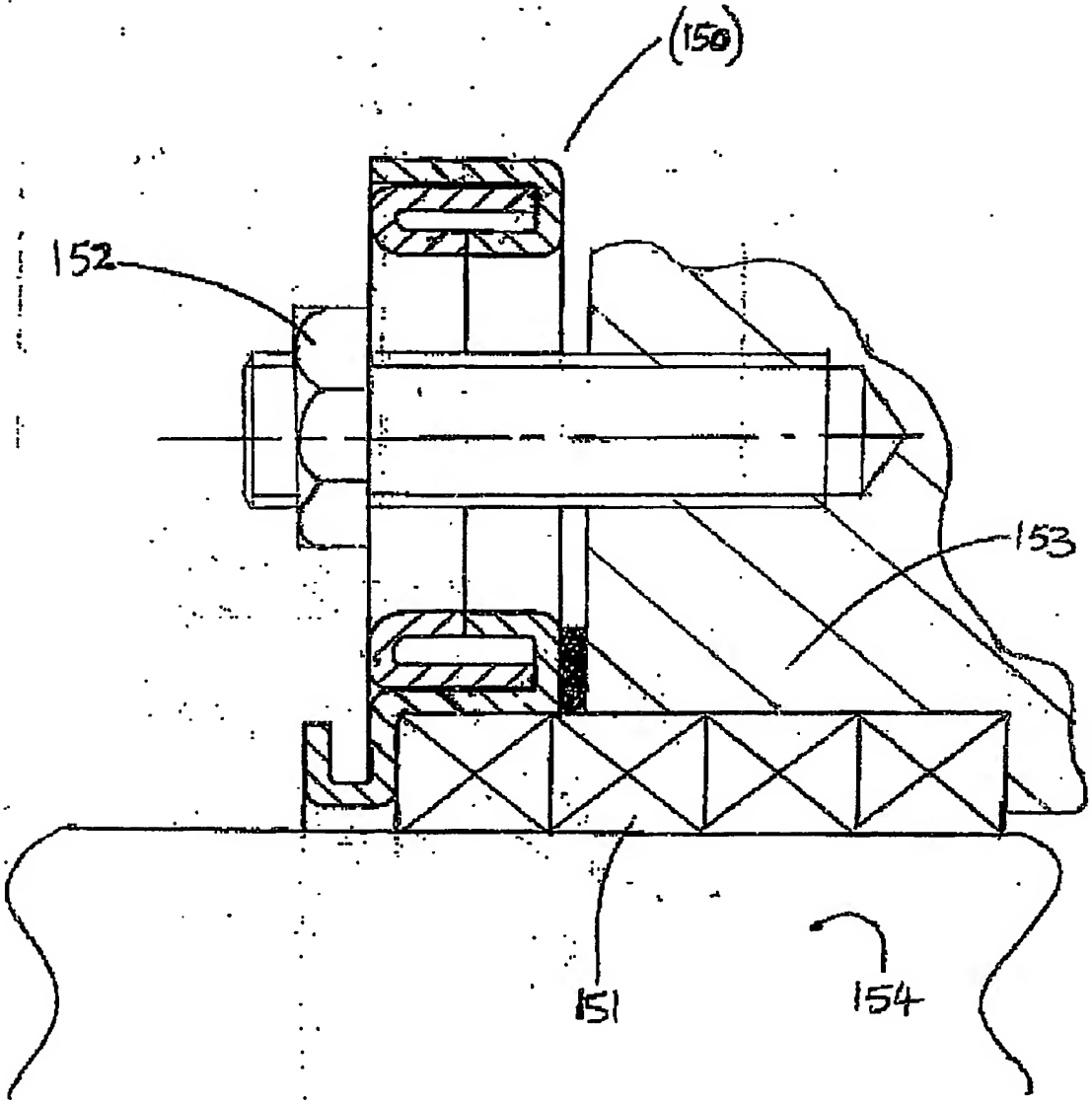

Fig. 12